

In the Specification:

[00001] This application is a continuation-in-part of U.S. Patent Application Serial No. 09/992,272, filed on November 14, 2001, now U.S. Patent No. 6,811,913, which issued on November 2, 2004, which claims the benefit of U.S. Provisional Application Serial No. 60/249,098, filed on November 15, 2000, and also claims the benefit of U.S. Provisional Application Serial No. 60/413,858, filed on September 26, 2002.

[000024] Figure 2 is a cross section of two cells, contained in a stack of such cells, of an alternative embodiment of the solid oxide fuel cell of the present invention.

[000025] Figure 3 is a cross-section of two cells, contained in a stack of such cells, of [[an]] another alternative embodiment of the solid oxide fuel cell of the present invention.

[000026] Figure 4 is a cross-section of two cells, contained in a stack of such cells, of [[an]] yet another alternative embodiment of the solid oxide fuel cell of the present invention.

[000028] Referring now to Figure 1, a cross section showing a single hollow circular cell 100 contained in a stack 102 of like cells of the system of the present invention is shown. It is noted that for purposes of explanation, the present invention is described as being circular; however the system of the present invention may also be employed with electrochemical systems of any shape used in the art, such as rectangular, square, or

ovoid. It is also noted that Fig. [[2]] 1 shows two adjacent cells 100 and 101, one above the other, having like elements. However, for purposes of explanation, stack 102 is referred to as having just one cell 100, but any numbers of cells 100 may be employed in stack 102. A cylinder centerline 104 is also shown. Cells 100 are defined by a hollow cavity in the center of cell 100. In alternative embodiments, the center of cell 100 can be defined by any number of hollow cavities. A center cylinder 106 is located inside stack 102 and defines a hollow cylindrical passage (stack fuel manifold) 108 which is adapted to provide a fuel to electrochemical stack 102 from a fuel source. An oxidizer tube 110 is also adjacent to electrochemical stack 102 to provide a source of oxygen or air to electrochemical stack 102. It should be appreciated that the locations of fuel manifold 108 and oxidizer tube 110 can be switched, with the other components of stack 102 being inverted accordingly. In other words, fuel manifold 108 could also be on the outside of stack 102 and oxidizer tube 110 on the inside. Both center cylinder 106 and oxidizer tube 110 are preferably comprised of a ceramic material, such as mullite, or a high-temperature metal alloy, such as Inconel.

[000043] Referring now to Figure [[3]] 2, an alternative embodiment of the present invention is shown and described. In Figure [[3]] 2, a cross section of a single hollow circular cell 200 contained in a stack 202 of like cells of the [[of the]] present invention is shown. For purposes of explanation, a cross-section of only a single cell 200 is shown with an adjacent cell 201, however any numbers of cells 200 may be employed in a stack of cells to comprise cell stack assembly 202.

[000052] Referring now to the operation of cell 200 and stack 202 shown in Fig. [[3]] 2, stack 202 is generally preheated by a suitable preheating means (not shown) conventional in the art and preheated to a suitable temperature that is sufficiently hot, such as about 850°C. Stack 202 is typically operated between about 600°C and 1000°C. A gaseous or liquid carbonaceous fuel is introduced into stack 202 via a fuel feed tube (not shown) at a sufficiently high flow rate so that the temperature of the carbonaceous fuel upon exit of stack 202 is low enough to prevent the formation of solid carbon or any other solid deposits to form or be deposited within the fuel feed tube. A typical maximum fuel feed temperature is about 400°C; however the temperature is fuel-type dependent. Any type of fuel that is conventional in the employment of solid oxide fuel cells may be employed with the present invention. The fuel gas mixture flows through fuel chamber 220 and air flows through air chamber 222. An electric current is generated and flows through stack 202 and an external circuit (not shown). Oxygen molecules diffuse from air chamber 222 into oxygen diffusion layer 214 and oxygen electrode 212 due to gaseous diffusion from an oxygen concentration gradient. In other words, the oxygen molecules diffuse into oxygen diffusion layer 214 and oxygen electrode 212 due to there being a higher concentration of oxygen molecules in air chamber 222 than in oxygen diffusion layer 214 and oxygen electrode 212. At and near the interface between oxygen electrode (cathode) 212 and electrolyte disc 210, the oxygen molecules are ionized into O^{2-} and flow through electrolyte disc 210 due to the chemical potential difference between oxygen electrode (cathode) 212 and fuel electrode (anode) 206. Fuel molecules, such as hydrogen (H_2) and carbon monoxide (CO) diffuse from fuel chamber

220 through porous fuel diffusion layer 204 and fuel electrode 206 while oxidation products, such as water (H_2O) and carbon dioxide (CO_2) diffuse in the opposite direction due to gaseous diffusion from concentration gradients. The fuel molecules are oxidized at or near the interface between fuel electrode (anode) 206 and electrolyte disc 210. This in turn releases electrons which are conducted along stack 202.